Coincidences of High Density Peaks in UVES Spectra of QSO Pairs

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Abstract. We present preliminary results of an investigation of the clustering properties of high matter density peaks between redshift ~ 2 and ~ 3, as traced by Lyman limit and Damped Lyα systems in spectra of close QSO pairs and groups.

1 Introduction

Paired lines of sight (LOS) toward high redshift quasars, with angular separations up to a few arcminutes, are a useful tool to investigate the clustering properties of absorption lines. We have obtained with UVES high resolution spectra ($R \simeq 37000$) of two QSO pairs with separations 1 and 5 arcmin and a QSO triplet with reciprocal separations 1, 8 and 8 arcmin, spanning the redshift range $1.6 \lesssim z \lesssim 3.2$ (see [1] for further details). We assume that high matter density peaks are traced by optically thick absorbers (i.e. with column density $N(\mathrm{HI}) \gtrsim 2\times10^{17}$ cm^{-2}). The present spectra are scanned to detect the presence of high density peaks. We find 5 systems with $N(\mathrm{HI}) \gtrsim 10^{19}$ cm^{-2} and 7 with $2\times10^{17} \lesssim N(\mathrm{HI}) \lesssim 10^{19}$ cm^{-2}. As a second step, we look systematically for coincident absorptions at the same redshift as the identified high column density systems.

2 Results

Out of 5 detected absorption systems with $N(\mathrm{HI}) \gtrsim 10^{19}$ cm^{-2}, 3 of them have a corresponding metal system in the companion LOS at a velocity difference of less than 200 km s^{-1}. One of them is at less then 1000 km s^{-1} from the emission redshift of the paired QSO (also marking a high density peak) and the last one has a corresponding, weak Lyα absorption line but no metal absorption within ~ 9000 km s^{-1}. From the number density of C IV systems with rest equivalent width $w_0 > 0.15$ Å, as a function of redshift [7], we compute the chance probability (in the hypothesis of null clustering) to detect a C IV absorption line within 200 km s^{-1} between $z = 2$ and 3, $\mathcal{P}(z) \simeq 0.001$. The transverse spatial separation over which these coincidences happen varies between ~ 4 and 7 h_{100}^{-1} comoving Mpc, which suggests that we are detecting the clustering signal of galactic objects, as verified in the past [2, 4, 3]. These separations could be indeed reasonable correlation lengths for normal or dwarf

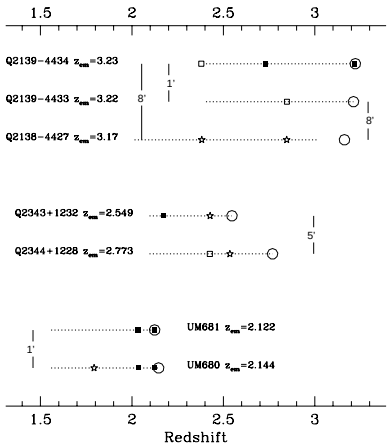

Figure 1: Summary of the observed coincidences as a function of redshift. The dotted lines mark the observed redshift ranges. The angular separations of the quasars are reported between the solid vertical lines. The symbols are: open square for metal systems, solid square for LLS with $N(\mathrm{HI}) < 10^{19}$ cm^{-2} and star for system with $N(\mathrm{HI}) > 10^{19}$ cm^{-2}. The big open circles mark the emission redshift of the quasars

galaxies at this redshift since at $z \sim 3$ the Lyman break galaxies are found to show correlation lengths $\sim 2\ h_{100}^{-1}$ Mpc [5, 6].

As for the 7 Lyman limit systems (LLS) with $N(\mathrm{HI}) \lesssim 10^{19}$ cm^{-2}, 4 form two coincident pairs along two LOS separated by ~ 1 arcmin; the similarity of the coincident absorptions suggests that the two LOS could be piercing a coherent filament-like structure. The remaining three systems do show corresponding Lyα absorption lines but no metal absorption within 3000 km s^{-1}, at transverse spatial separations of $\sim 3.8\ h_{100}^{-1}$ Mpc, and in the triplet $\sim 6.7\ h_{100}^{-1}$ Mpc and $\sim 840\ h_{100}^{-1}$ kpc.

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